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ROLL FOR SHEET EXTRUSION MOLDING
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Claims

1. A roll for sheet extrusion molding, characterized by the fact that in a roll for molding a smooth surface in a sheet extruder that extrudes a plastic sheet in which at least one surface is a smooth surface, it consists of a shaft core part, a rubber layer for covering the shaft core part, and a metal layer for covering the rubber layer; said metal layer is comprised of a seamless tubular product mainly composed of nickel obtained by an electric casting method and a coated film mainly composed of chromium for covering said tubular product.

2. The roll for sheet extrusion molding of Claim 1, characterized by the fact that the surface of the metal layer is concaved and convexed at a central line average roughness Ra of 0.02-0.08 μm.

3. Detailed explanation of the invention

[0001]

(Technical field of the invention)

[1] Numbers in the margin indicate pagination in the foreign text.

The present invention pertains to a mirror roll for molding a smooth surface in a sheet extruder that uses a thermoplastic resin as a raw material and extrudes a plastic sheet in which at least one surface is a smooth surface. Plastic sheets in which at least one surface is a smooth surface, for example, Fresnel lens sheet, lenticular lens sheet, prism lens sheet, etc., are used in optical usages, and a high smoothness is required for the opposite surface of a surface with a lens shape. The roll of the present invention is appropriately used for molding such a smooth surface.

[0002]

(Prior art)

In lens function sheets represented by Fresnel lens sheet, lenticular lens sheet, prism lens sheet, etc., a shape for realizing the above-mentioned lens function is rendered to one surface, and the opposite surface of the surface is required to be a mirror face with high smoothness (mirror face). Generally, in manufacturing the above-mentioned lens function sheets by a continuous extrusion molding method with excellent mass producibility, a method that passes through a molten resin in a film shape between an embossing roll for rendering a lens-shaped surface and a mirror roll for molding a mirror face

opposite to it and sandwiches it by pressing, so that a fine concave and convex shape for realizing an optical function is transferred to one surface and a smooth mirror face is formed on the other surface is employed.

[0003] As the mirror roll, i) a metal mirror roll whose surface is polished or plated, ii) a mirror rubber roll in which a shaft core part is coated by pouring and curing silicon rubber, etc., on the surface of the shaft core part by using a mold whose inner surface is processed like a mirror or a mirror rubber roll in which a rubber layer is installed on the surface of the shaft core part by a flow casting method.

[0004]

(Problems to be solved by the invention)

The thickness precision of an extruded sheet using a T die mold has been remarkably improved by the development of recent mold designs and working techniques, however an epoch-making improvement proposal has not been found out for a thickness irregularity between two adjacent points. Such a thickness irregularity appears as a nonuniform rendered shape of the lens function sheet, resulting in the decrease of the quality, that is, the deterioration of partial optical functions.

[0005] The embossing roll is basically a metal roll in which a desired lens shape is carved, and a lens function sheet is molded by passing through a molten resin in a film shape between the embossing roll and many kinds of various mirror rolls in combination and sandwiching it by pressing.

[0006] On the other hand, the mirror roll has the following problems. First, the metal mirror roll i) is excellent in the precision and the non-defectiveness of the mirror face, however it does not have a capability of absorbing the thickness irregularity of the resin by its own flexibility. Therefore, in case the molten resin is passed through in a film shape by using the metal mirror roll, the pressure is concentrated on its thick part by the thickness irregularity of the resin, so that the pressure of its thin part is deficient. Therefore, the thin part has an insufficiently rendered shape.

[0007] Also, since the mirror rubber roll (ii) absorbs the thickness irregularity of the resin by its own flexibility, the molten resin can be passed through in a film shape and sandwiched by pressing at a uniform pressure. However, microcracks due to gases being generated during the preparation of the rubber layer through pouring and curing cannot be avoided, and the rubber is degraded by being

exposed to the high-temperature resin and cannot be used in a short time.

[0008] Thus, the conventional mirror rolls being used for the lens function sheet extrusion molding respectively have drawbacks, and the manufacture yield of the lens function sheet is lowered, so that its optical performances are limited.

[0009] The purpose of the present invention is to provide a roll for sheet extrusion molding in which the above-mentioned problems are overcome.

[0010]

(Means to solve the problems)

These inventors reviewed mirror rolls that absorbed the thickness irregularity of a resin, sandwiched a sheet by pressing at a uniform pressure, and could render a high-precision mirror face to the sheet to obtain good optical performances through a uniform shape rendering. As a result, the roll for sheet molding of the present invention was provided.

[0011] The roll for sheet extrusion molding of the present invention is characterized by the fact that in the roll for molding a smooth surface in a sheet extruder that extrudes a plastic sheet in which at least one surface is a smooth surface, it consists of a shaft core part, a rubber layer

for covering the shaft core part, and a metal layer for covering the rubber layer; said metal layer is comprised of a seamless tubular product mainly composed of nickel obtained by an electric casting method and a coated film mainly composed of chromium for covering said tubular product.

[0012] The thickness of the tubular product of said metal layer is preferably 0.03-0.3 mm. Also, the thickness of the coated film of said metal layer is preferably 0.01-0.1 mm.

[0013] Furthermore, in order to prevent the adhesion of the smooth surface of the sheet being obtained to the other smooth surface, the surface of the metal layer is concaved and convexed at a central line average roughness Ra of

/3

0.02-0.08 μm.

[0014] Next, the present invention is explained in further detail.

[0015] The shaft core part of the roll for sheet molding of the present invention may be the same as the shaft core part of the conventional mirror rolls and is not particularly limited. The shaft core part may also have attached parts for driving the roll.

[0016] Usually, during the mold extrusion molding of the sheet, since a molten metal is passed through in a film shape between two rolls as a pair and sandwiched by pressing, it is necessary for the roll have a rigid structure formed of a material that withstands the pressure. Therefore, as the shaft core part of the mirror roll, a shaft core part made of a metal such as steel, stainless steel, and aluminum is appropriately adopted.

[0017] Also, since the roll temperature generally has a large influence on the transfer characteristic in the mold extrusion molding, a shaft core part with a structure that can regulate the roll to an appropriate temperature is preferable. As an appropriate temperature regulation means being employed, an electric heating method that assembles a sheathed heater into the shaft core part and heats the roll, an induction heat generation method that heats the roll by an electromagnetic induction action of an induction heat generation type coil, a heating medium circulation heating method that indirectly heats the roll by circulating a heating medium for controlling the temperature in a flow passage installed in the shaft core part, etc., are mentioned. The heating medium circulation heating method is especially preferable. The heating medium may be a gas, however a liquid such as water and oil

is preferable. As an appropriate example of the heating medium flow passage, a heating medium flow passage having a structure such as two sets of spiral passages or four sets of spiral passages is mentioned.

[0018] The material of said rubber layer may have a rubber elasticity at room temperature or higher, and for example, neoprene rubber, NBR rubber, silicone rubber, etc., are mentioned. In particular, a material with a rubber hardness of 60-90° prescribed in JIS K7215 is appropriate, and in consideration of the life at high temperature, a silicone rubber is appropriate. In the material of the rubber layer, various kinds of fillers such as SiO_2 powder may also be included to adjust the rubber hardness.

[0019] The thickness of said rubber layer is preferably 0.5 mm or greater, for instance, to the degree that its elastic force can be maintained. If the thickness of the rubber layer is greater than 0.5 mm, the amount of elastic formation of the rubber layer is deficient, and the thickness irregularity of the resin is not likely to be able to be completely absorbed.

[0020] The surface state of said rubber layer may be a state in which the metal layer being externally clad on it can be adhered and fixed, and it is preferable to

appropriately roughly finish the adhesive surface of the rubber layer in accordance with the adhesion of the rubber.

[0021] Said metal layer consisting of a seamless tubular product (hereinafter, called a nickel tube) mainly composed of nickel obtained by an electric casting method and a coated film (hereinafter, called a chromium coated film) mainly composed of chromium for covering said tubular product. The nickel tube prepared by the electric casting method is excellent in the mirror face characteristic and the non-defectiveness and excellent in the thickness precision. On the other hand, its elasticity is low, and the nickel tube is easily plastically deformed by a local stress. Accordingly, with the formation of a chromium coated film on the surface of the nickel tube, the above-mentioned defects are avoided, and an elasticity without a practical trouble can be rendered.

[0022] The thickness of the nickel tube of the metal layer is preferably 0.03-0.3 mm. If the thickness is smaller than 0.03 mm, the tube is easily broken when sandwiching by pressing, a limitation is sometimes generated in the setup of the pressure. If the thickness is greater than 0.3 mm, the flexibility of the tube is deficient, and the thickness irregularity of the resin cannot be completely absorbed.

[0023] The thickness of the chromium coated film of the metal layer is preferably 0.01-0.1 mm. If the thickness is smaller than 0.01 mm, the elasticity to the degree that the chromium coated film is not easily plastically deformed by a local stress cannot be obtained. If the thickness is greater than 0.1 mm, the adhesive strength with the nickel tube is lowered, and the chromium coated film is sometimes peeled off.

[0024] In preparing the metal layer, it is preferable to continuously render the chromium coated film to the surface of the nickel tube by a wet-plating method without a time delay after obtaining the nickel tube by an electric casting method using a cylindrical parent mold in terms of adhesion of both of them and surface glossiness.

[0025] The rubber layer and the metal layer may be fixed with an adhesive and may also be fixed by strengthening the frictional force by cooling and contracting the rubber layer and inserting it into the nickel tube of the metal layer. The mirror roll of the present invention can also be prepared by positioning the shaft core part and the nickel tube in advance and pouring a liquid rubber between them.

[0026] After obtaining the mirror roll of the present invention in this manner, the mirror face characteristic

and the non-defectiveness may also be further improved by polishing the roll surface. On the contrary, in order to secure the handling characteristic by preventing the adhesion with the other smooth surface, the surface of the metal layer may also be concaved and convexed at a central line average roughness Ra of 0.02-0.08 μm.

[0027] The concaving and convexing method of the metal layer surface is not particularly limited as long as uniform projections and recession are obtained on the entire surface, and an appropriate method can be employed. For example, a method that improves the surface smoothness by post-polishing of sandblasting and obtains a desired surface smoothness, a method that applies only the sandblasting by a dry method using a glass bead of about 200 mesh, a method that adjusts a Sergent[transliteration] bath to render gloss to the surface when the nickel tube is prepared by an electric casting method, etc., are mentioned.

[0028] The smoothness of the metal layer surface is very important on the surface characteristics of the sheet being obtained using the roll and has a central line average roughness Ra of preferably 0.02-0.08 μm, more preferably 0.03-0.06 μm. If the center line average roughness is smaller than 0.02 μm, the surface is too smooth, and the

adhesion with the other surface being contacted is easily caused. If the center line average roughness is greater

/4

than 0.08 μm, the smoothness is damaged too much, so that the optical functions intrinsic to the sheet are considerably lowered.

[0029]

(Embodiments of the invention)

Next, the present invention is mentioned in detail by application examples.

[0030] Application Example 1

i) A shaft core part was prepared by using a S45C steel material, and a flow passage for circulating a heating medium oil was installed in it. The flow passage has a four-set spiral structure.

[0031] ii) Next, the shaft core part was coated with a liquid silicone rubber containing SiO_2 powder as a filler, and after curing the rubber, the thickness of the rubber layer was adjusted to 2 mm by polishing. The rubber hardness after curing was 75°.

[0032] iii) Next, a nickel tube with a thickness of 0.2 mm was prepared by an electric casting method, and a hard chromium coated film with a thickness of 0.05 mm was plated on the surface of said nickel tube by a wet type plating

method. The inner diameter of the nickel tube was matched with the outer diameter of the shaft core part after the above-mentioned rubber coating. The hard chromium plated coated film surface for covering the nickel tube had good mirror face characteristic. A silicon group adhesive was spread on the rubber layer surface that coated the shaft core part, and the rubber layer that coated the shaft core part was inserted into the nickel tube, so that the rubber layer was coated with the metal layer consisting of the nickel tube and the chromium coated film. Then, the adhesive was cured, so that a mirror roll of the present invention was obtained.

[0033] The structure of the roll for sheet extrusion molding obtained is shown in Figure 1. In Figure 1, 2 is a shaft core part, 3 is a rubber layer for covering the shaft core part, 4 is a metal layer for covering the rubber layer, 4a is a chromium coated film of the metal layer, and 1 is a roll for sheet extrusion molding of the present invention.

[0034] Application Example 2

Similarly to Application Example 1 except for setting the thickness of the nickel tube to 0.1 mm and applying sandblasting of a dry type method by using a glass bead

with 400 mesh to the surface of the metal layer after curing the adhesive, a mirror roll was obtained.

[0035] Comparative Example 1

Chromium was plated on the surface of the same shaft core part made of S45C steel material as that used in Application Example 1, so that a mirror roll was obtained.

[0036] Comparative Example 2

A mold whose inner surface was processed like a mirror, and a silicone rubber was poured and cured between the inner surface of the mold and the surface of the same shaft core part made of S45C steel material as that used in Application Example 1, so that a mirror rubber roll in which the shaft core part was coated was obtained.

[0037] Comparative Example 3

The same shaft core part made of S45C steel material as that used in Application Example 1 was coated with a heat-contractible tube made of fluororesin, and the surface was polished like a mirror, so that a mirror fluororesin roll was obtained.

[0038] Comparative Example 4

Similarly to Application Example 1 except for not rendering a hard chromium plated coated film on the surface of the nickel tube, a mirror roll was obtained.

[0039] Performance evaluation:

Each mirror roll obtained in the application examples and the comparative examples and an embossing roll for prism molding were respectively installed in a take-off machine, and a polycarbonate molten resin extracted from a T die was passed through in a film shape between these rolls and sandwiched by pressing, so that embossing was applied. The resin temperature right after extracting from the T die was 270°C, the temperature of the heating medium flowing in the embossing roll was controlled to 130°C, and the temperature of the heating medium flowing in the mirror roll of the present invention was controlled to 30°C. The molded sheet obtained was favorably peeled off the embossing roll, and its thickness was 200 μm.

[0040] The sheet prepared was observed, and the transfer characteristic of the embossing shape, the smoothness of the mirror face, the non-defectiveness of the mirror face, the roll life, the generation of roll surface defects due to foreign matters in the resin raw material, the non-adhesion with an acrylic plate in which the center line average roughness Ra was 0.02 μm of the smooth sheet surface and the surface were evaluated. The roll life was indicated by the time until the rubber layer or the meta layer was peeled off or the time until damages were

generated on the surface of the rubber layer or the surface of the metal layer.

[0041] The evaluation results are shown in Table 1

[0042]

評価項目	実施例		比較例			
	1	2	1	2	3	4
エンボス形状転写均一性	○	○	×	○	△	○
鏡面平滑性 (Ra)	250Å	400Å	250Å	700Å	2000Å	250Å
剥離性 (欠陥個数)	なし	なし	なし	8	6	なし
ロール寿命 (時間)	>1000	>1000	>1000	150	800	>1000
異物による欠陥発生	なし	なし	なし	なし	なし	あり
非粘着性	×	○	×	○	○	×

/5

1. Evaluation item

2. Application Example

3. Comparative Example 4

4. Embossing shape transfer uniformity

5. Mirror face smoothness (Ra)

6. Non-defectiveness (number of defect)

7. Roll life (h)

8. Defect generation due to foreign matters

9. Non-adhesion

10. None

11. Present

[0043] In the embossing shape transfer uniformity of Table 1, O means very good uniformity, Δ means insufficient uniformity, and X means poor uniformity.

[0044] Also, in the non-adhesion of Table 1, O means that the adhesion with the acrylic plate is not caused, and X means that the adhesion with the acrylic plate is caused.

[0045] As seen from Table 1, in the mirror roll of Application Example 1, a good evaluation was obtained in all the items except for the non-adhesion. Also, in the mirror roll of Application Example 2, a good evaluation was obtained in any of these items.

[0046]

(Effects of the invention)

According to the present invention, a mirror roll that absorbs the thickness irregularity of a resin, sandwiches a sheet by pressing at a uniform pressure, and renders a high mirror face characteristic to the sheet is realized, so that an extruded sheet in which the embossing rendering characteristic is uniform and the smoothness and non-defectiveness of the surface is remarkably improved can be obtained. Therefore, the present invention can provide a resin sheet with excellent optical precision and good mass producibility at low cost.

[0047] Also, the present invention is applied to molding of a transparent sheet such as transparent polypropylene resin sheet being provided for packing, etc., as well as the above-mentioned lens sheet, so that the smoothness of said transparent sheet is improved, thereby being able to improve the transparency.

Brief description of the figure

Figure 1 is a horizontal sectional view showing the roll for sheet extrusion molding of the present invention.

Explanation of symbols:

1 Roll for sheet extrusion molding of the present invention

2 Shaft core part

3 Rubber layer

4 Metal layer

4a Nickel tube

4b Chromium coated film

【図1】